Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **October/November 2018**

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

5690947008

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.
Electronic calculators may be used.

This document consists of **21** printed pages and **3** blank pages.

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Data

speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
unified atomic mass unit	$1\,\text{u} = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$

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Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
gravitational potential	$\phi = -\frac{Gm}{r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $v = \pm\omega\sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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[Turn over

1 The radius of the Earth is approximately 6.4×10^6 m, and the radius of the Moon is approximately 1.7×10^6 m. A student wishes to build a scale model of the Solar System in the classroom, using a football of radius 0.12 m to represent the Earth.

Which object would best represent the Moon?

A basketball

B cherry

C golf ball

D tennis ball

2 When a beam of light is incident on a surface, it delivers energy to the surface. The intensity of the beam is defined as the energy delivered per unit area per unit time.

What is the unit of intensity, expressed in SI base units?

A $\text{kg m}^{-2}\text{ s}^{-1}$ **B** $\text{kg m}^{2}\text{ s}^{-3}$ **C** kg s^{-2} **D** kg s^{-3}

3 A ship is travelling with a velocity of 8.0 km h^{-1} in a direction 30° east of north.

What are the components of the ship's velocity in the east and north directions?

	component of velocity in east direction / km h^{-1}	component of velocity in north direction / km h^{-1}
A	4.0	4.0
B	4.0	6.9
C	4.6	6.9
D	6.9	4.0

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4 A micrometer screw gauge is used to measure the diameter of a copper wire.

The reading with the wire in position is shown in diagram 1. The wire is removed and the jaws of the micrometer are closed. The new reading is shown in diagram 2.

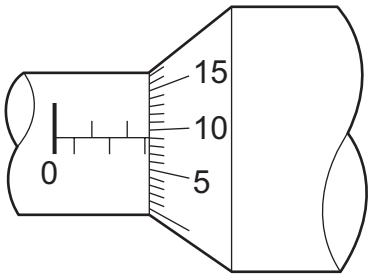


diagram 1

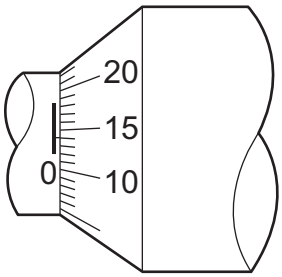


diagram 2

What is the diameter of the wire?

A 1.90 mm **B** 2.45 mm **C** 2.59 mm **D** 2.73 mm

5 A digital meter has an accuracy of ±1%.

The meter is used to measure the current in an electrical circuit.

The reading on the meter varies between 3.04 A and 3.08 A.

What is the value of the current, with its uncertainty?

A (3.06 ± 0.02) A

B (3.06 ± 0.04) A

C (3.06 ± 0.05) A

D (3.06 ± 0.07) A

6 A tennis ball is thrown horizontally in air from the top of a tall building.

The effect of air resistance is **not** negligible.

What happens to the horizontal and to the vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	constant	constant
B	constant	increases at a constant rate
C	decreases to zero	increases at a constant rate
D	decreases to zero	increases to a maximum value

7 Water is pumped through a hose-pipe at a rate of 90 kg per minute. Water emerges horizontally from the hose-pipe with a speed of 20 $m\,s^{-1}$.

What is the minimum force required from a person holding the hose-pipe to prevent it moving backwards?

A 30 N **B** 270 N **C** 1800 N **D** 108 000 N

8 A ball of mass m is thrown vertically into the air. When the ball has speed v, the air resistance acting on the ball is F.

What is the magnitude of the acceleration of the ball when its speed is v as it rises and as it falls?

	acceleration when ball is rising	acceleration when ball is falling
A	$g - \frac{F}{m}$	$g - \frac{F}{m}$
B	$g - \frac{F}{m}$	$g + \frac{F}{m}$
C	$g + \frac{F}{m}$	$g - \frac{F}{m}$
D	$g + \frac{F}{m}$	$g + \frac{F}{m}$

9 What is a statement of the principle of conservation of momentum?

A A force is equal to the rate of change of momentum of the body upon which it acts.

B In a perfectly elastic collision, the relative momentum of the bodies before impact is equal to their relative momentum after impact.

C The momentum of a body is the product of the mass of the body and its velocity.

D The total momentum of a system of interacting bodies remains constant, providing no resultant external force acts on the system.

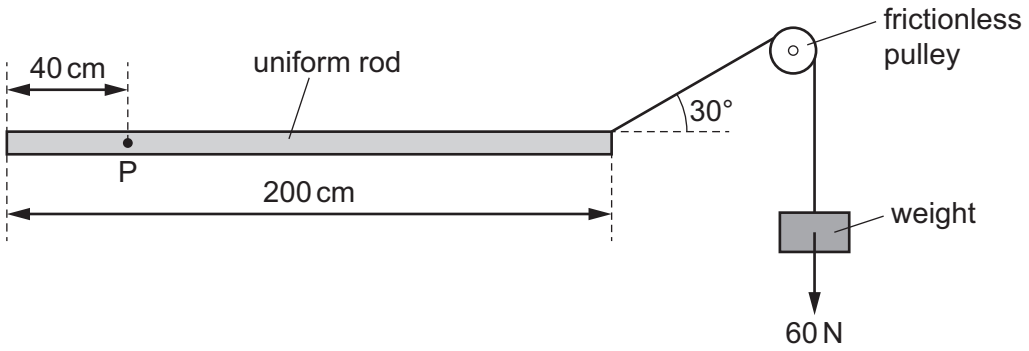
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10 A charged particle is placed in a uniform field of force. The direction of the force on the particle is opposite to the direction of the field.

What is the field and what is the charge on the particle?

	field	charge on particle
A	electric	negative
B	electric	positive
C	gravitational	negative
D	gravitational	positive

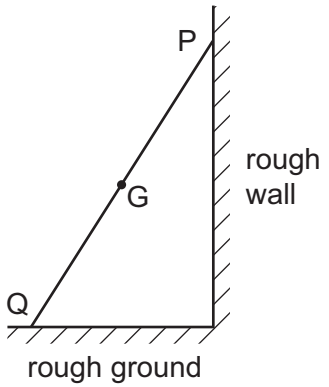
11 A uniform rod of length 200 cm is freely pivoted at point P. The rod is held horizontally in equilibrium by a 60 N weight that is attached to the rod by a string passing over a frictionless pulley.



What is the weight of the rod?

A 30 N **B** 60 N **C** 80 N **D** 140 N

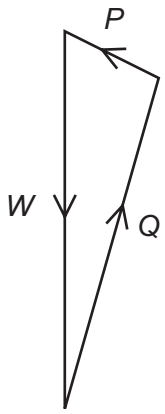
12 A ladder rests in equilibrium on rough ground against a rough wall.



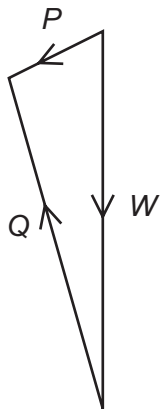
The weight *W* of the ladder acts through the centre of gravity G. Forces also act on the ladder at P and at Q. These forces are *P* and *Q* respectively.

Which vector triangle represents the forces on the ladder?

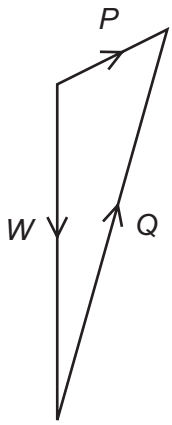
A



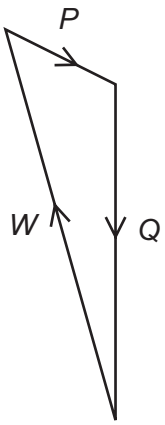
B



C

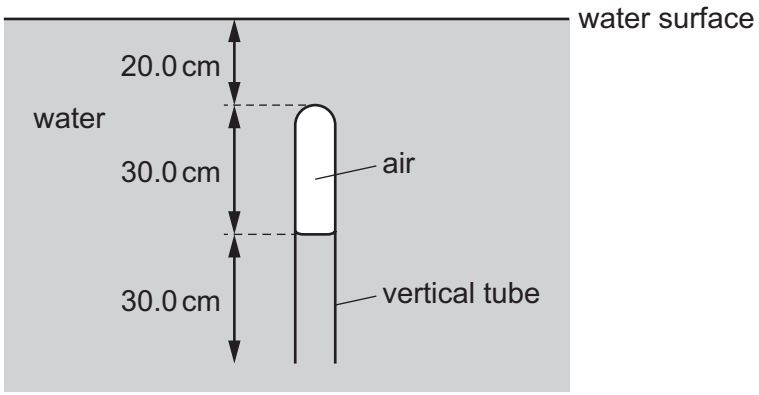


D



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13 A vertical tube, closed at one end, is immersed in water. A column of air is trapped inside the tube.



The density of water is $1000\,kg\,m^{-3}$.

What is the difference between the pressure of the air in the tube and the atmospheric pressure?

A 1960 Pa **B** 2940 Pa **C** 4910 Pa **D** 7850 Pa

14 A rocket is fired upwards.

As it accelerates upwards after leaving the launch pad, which forms of energy are changing?

A chemical energy, gravitational potential energy and kinetic energy

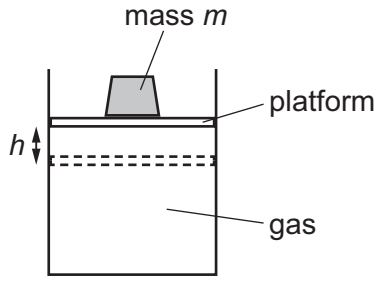
B chemical energy and gravitational potential energy only

C chemical energy and kinetic energy only

D gravitational potential energy and kinetic energy only

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15 A mass m is on top of a platform that is supported by gas in a cylinder of cross-sectional area A, as shown.



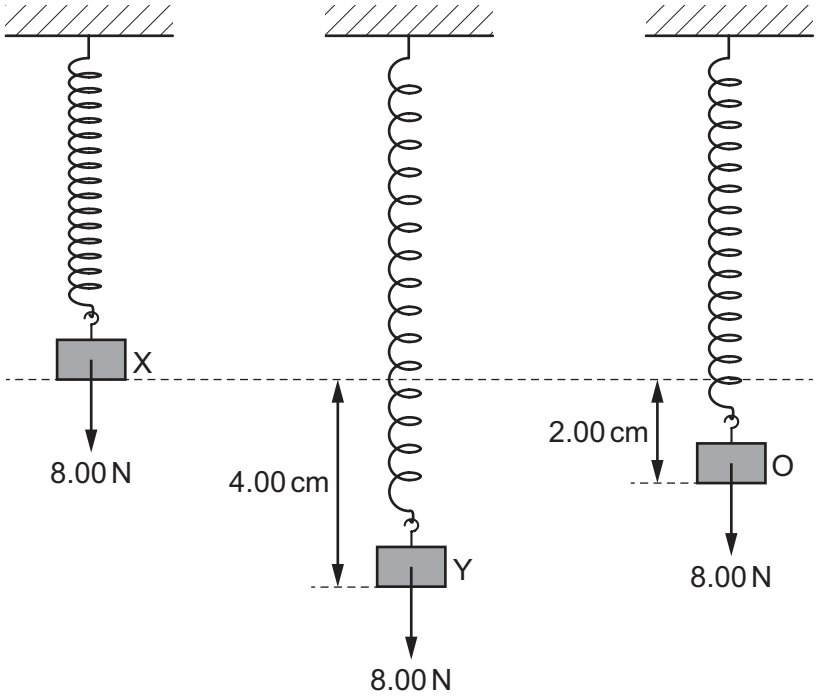
The platform has negligible mass and can move freely up and down.

The gas is heated and expands so that the mass is raised through a height h. Atmospheric pressure is p.

What is the ratio $\frac{\text{gain in gravitational potential energy of the mass}}{\text{work done by the gas}}$?

A $\frac{mg}{pA}$ **B** $\frac{mg}{mg + pA}$ **C** $\frac{pA}{mg}$ **D** $\frac{mg - pA}{mg}$

16 An 8.00 N weight is attached to the lower end of a spring which is fixed at its upper end. The weight is initially held at rest at position X and the spring is unstretched. The weight is then released and falls to position Y, which is 4.00 cm below X. The weight oscillates and then eventually comes to rest at O, which is 2.00 cm below X.



How much energy is lost from the system?

A 0.04 J **B** 0.08 J **C** 0.16 J **D** 0.32 J

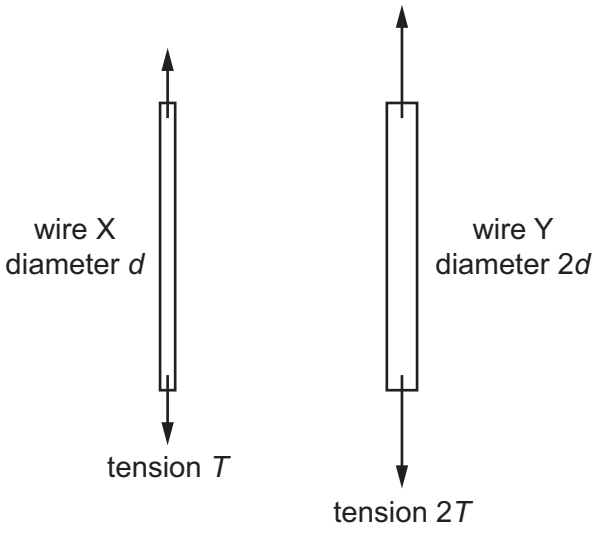
17 The force resisting the motion of a car is proportional to the square of the car's speed. The magnitude of the force at a speed of 20.0 m s^{-1} is 800 N.

What useful output power is required from the car's engine to maintain a steady speed of 40.0 m s^{-1}?

A 32 kW **B** 64 kW **C** 128 kW **D** 512 kW

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18 Two wires X and Y are made from the same material. Wire Y has twice the diameter and experiences twice the tension of wire X. The wires obey Hooke's law and have the same original length.



Wire X has extension *e*.

What is the extension of wire Y?

A $\frac{e}{4}$ **B** $\frac{e}{2}$ **C** e **D** $2e$

19 What is represented by the gradient of a graph of force (vertical axis) against extension (horizontal axis) for a wire obeying Hooke's law?

A elastic limit

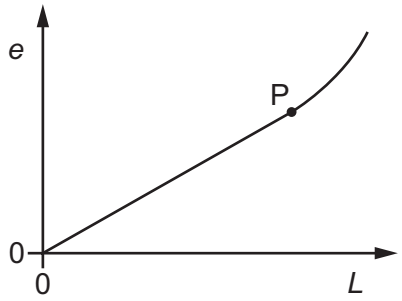
B spring constant

C stress

D Young modulus

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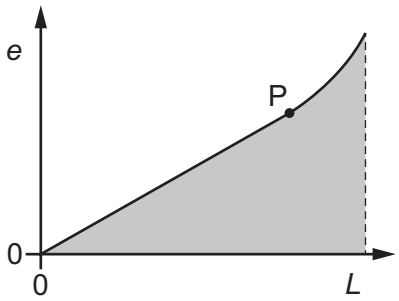
20 Forces are applied to the ends of a rod so that its length increases. The variation with load *L* of the extension *e* of the rod is shown.



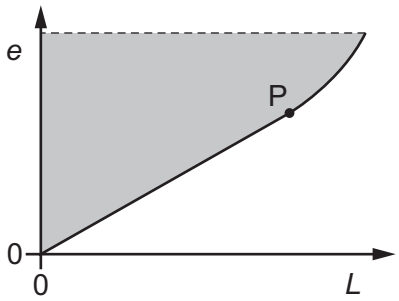
The point P is the elastic limit.

Which shaded area represents the work done during the plastic deformation of the rod?

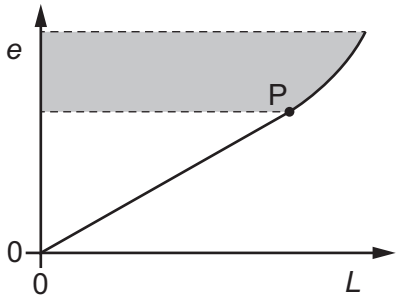
A



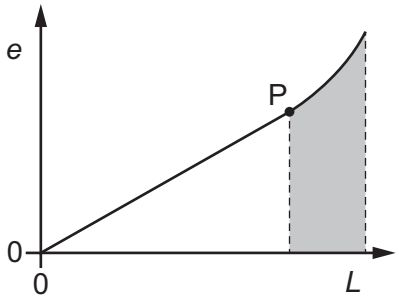
B



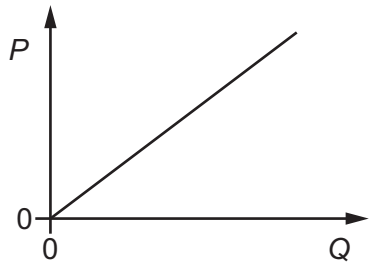
C



D



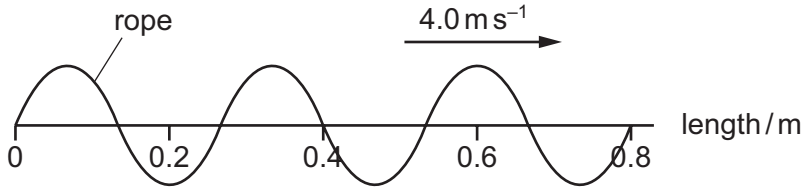
21 The graph shows the variation of a quantity *P* with a quantity *Q* for a sound wave travelling in air.



What could *P* and *Q* be?

	P	*Q*
A	amplitude	intensity
B	frequency	wavelength
C	speed	frequency
D	wavelength	period

22 A vibration generator produces a progressive wave on a rope. The diagram shows the rope at one instant. The wave travels at a speed of $4.0\,m\,s^{-1}$.

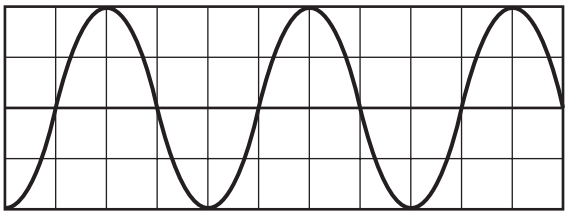


What are the wavelength and the frequency of the wave?

	wavelength / m	frequency / Hz
A	0.13	15
B	0.13	30
C	0.27	15
D	0.27	30

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23 The diagram shows the waveform of a signal displayed on a cathode-ray oscilloscope.



The time-base is set at 5.0 ms per division.

The Y-gain is set at 5.0 mV per division.

What are the amplitude and the frequency of the signal?

	amplitude / mV	frequency / Hz
A	10	50
B	10	100
C	20	50
D	20	100

24 A jet aircraft travels at a speed of $0.8v$ where v is the speed of sound. The aircraft approaches a stationary observer. The frequency of sound emitted by the aircraft is 100 Hz.

Which frequency does the observer hear?

A 56 Hz **B** 180 Hz **C** 400 Hz **D** 500 Hz

25 A telescope detects and analyses some electromagnetic radiation of wavelength 2 cm.

Which type of telescope is it?

A microwave telescope

B optical telescope

C radio telescope

D X-ray telescope

26 What may be used to produce stationary waves?

A blowing air over the top of an empty bottle

B making a loud sound near a mountain

C passing monochromatic light through a double slit

D passing water waves through a narrow slit

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27 What is an example of the diffraction of a wave?

A laser light travelling along an optic fibre

B light waves forming images on a cinema screen

C microwaves passing the edge of a metal plate

D sound waves diverging as they pass through air

28 When the light from two lamps falls on a screen, no interference pattern can be obtained.

Why is this?

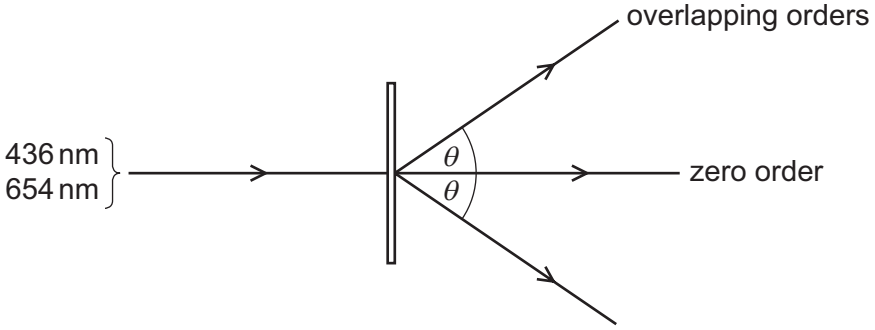
A The lamps are not point sources.

B The lamps emit light of different amplitudes.

C The light from the lamps is not coherent.

D The light from the lamps is white.

29 A beam of light consists of two wavelengths of 436 nm and 654 nm. A diffraction grating of 5.00×10^5 lines m^{-1} produces a diffraction pattern in which the second order of one of these wavelengths occurs at the same angle θ as the third order of the other wavelength.

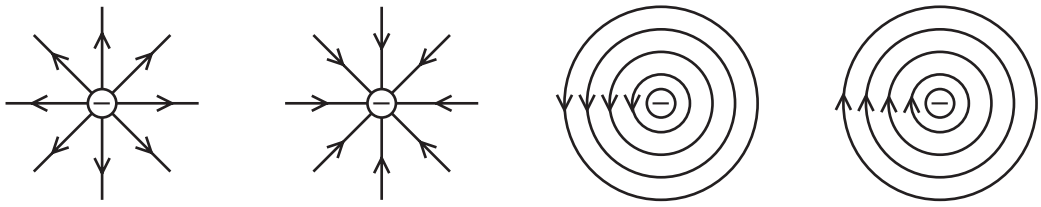


What is the angle θ?

A 19.1° **B** 25.8° **C** 40.8° **D** 78.8°

30 Which diagram shows the electric field lines surrounding an isolated negative point charge?

A **B** **C** **D**



31 A beam of electrons is directed into an electric field and is deflected by it.

Diagram 1 represents an electric field in the plane of the paper.
Diagram 2 represents an electric field directed perpendicular to the plane of the paper.

The lines **A**, **B**, **C** and **D** represent possible paths of the electron beam. All paths are in the plane of the paper.

Which line best represents the path of the electrons inside the field?

diagram 1

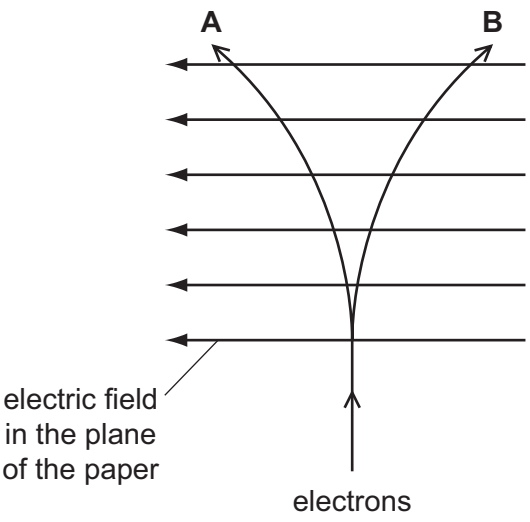
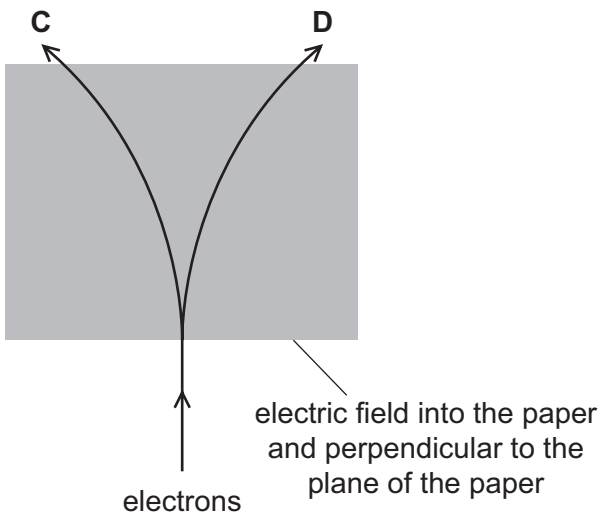


diagram 2



32 A charged particle of charge q and mass m is initially at rest in a uniform electric field. The field is produced by parallel metal plates separated by a distance d and having a potential difference V between them.

What is an expression for the acceleration of the charged particle?

A $\frac{md}{qV}$ **B** $\frac{mV}{qd}$ **C** $\frac{qd}{mV}$ **D** $\frac{qV}{md}$

33 When there is a current of 5.0 A in a copper wire, the average drift velocity of the free electrons is $8.0 \times 10^{-4}\,\text{m s}^{-1}$.

What is the average drift velocity in a different copper wire that has twice the diameter and a current of 10.0 A?

A $4.0 \times 10^{-4}\,\text{m s}^{-1}$

B $8.0 \times 10^{-4}\,\text{m s}^{-1}$

C $1.6 \times 10^{-3}\,\text{m s}^{-1}$

D $3.2 \times 10^{-3}\,\text{m s}^{-1}$

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34 What is equivalent to one volt?

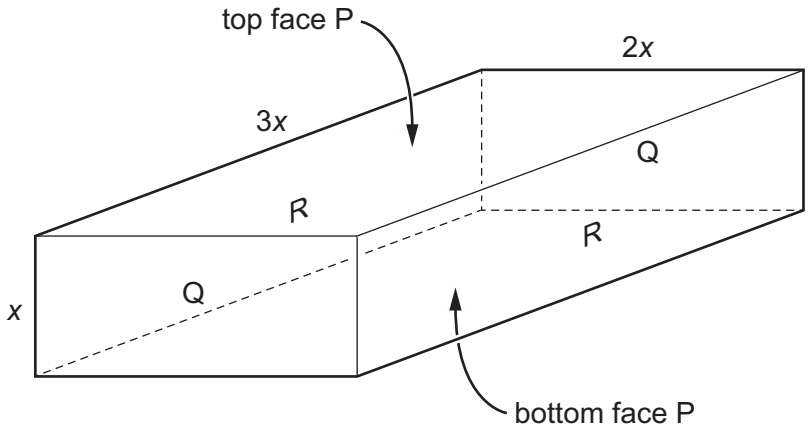
A one coulomb per second

B one joule per coulomb

C one joule per second

D one joule second per coulomb squared

35 The diagram shows a rectangular block with dimensions x, $2x$ and $3x$.



Electrical contact can be made to the block between opposite pairs of faces (for example, between the faces labelled R).

Which statement describing the electrical resistance of the block is correct?

A It is maximum between the faces labelled P.

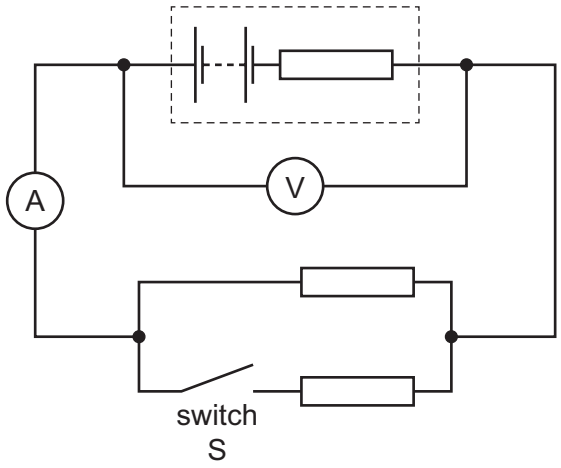
B It is maximum between the faces labelled Q.

C It is maximum between the faces labelled R.

D It is the same, whichever pair of faces is used.

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36 A battery, with internal resistance, is connected to a parallel arrangement of two resistors and a switch S, as shown.

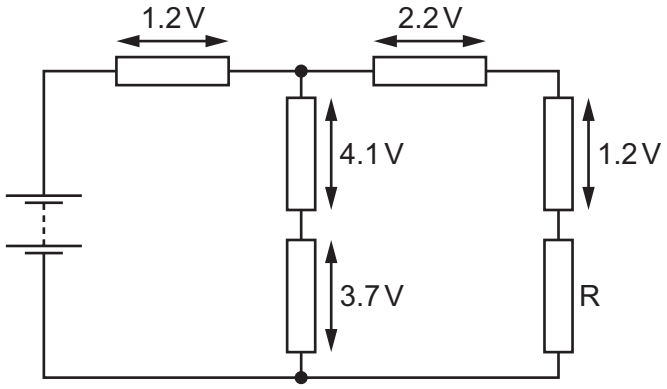


Initially switch S is open.

What happens to the voltmeter and ammeter readings when switch S is closed?

	voltmeter reading	ammeter reading
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

37 A battery is connected to a network of six resistors, as shown.



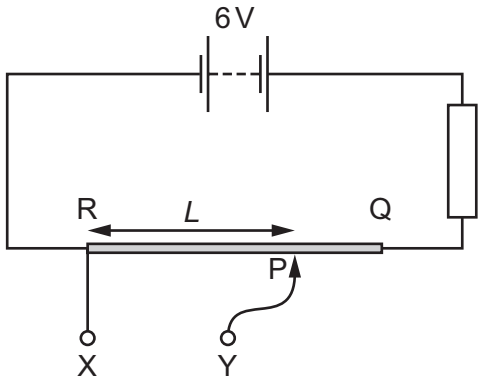
The potential differences across five of the resistors are labelled on the diagram.

What is the potential difference across resistor R?

A 4.4 V **B** 4.6 V **C** 6.6 V **D** 11.2 V

38 The diagram shows a battery of electromotive force (e.m.f.) 6 V, connected in series with a resistor and a uniform resistance wire RQ of length 60 cm.

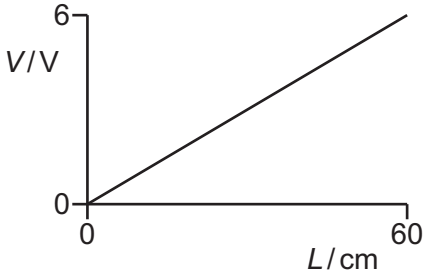
The resistance of RQ is equal to the resistance of the resistor.



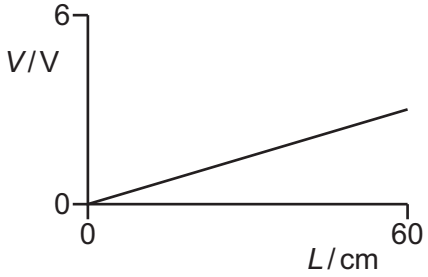
Terminal X is connected to fixed point R. Terminal Y is connected to point P, a connection that may be made at any position along the wire. *L* is the distance between R and P.

Which graph shows the variation with *L* of the potential difference (p.d.) *V* across XY?

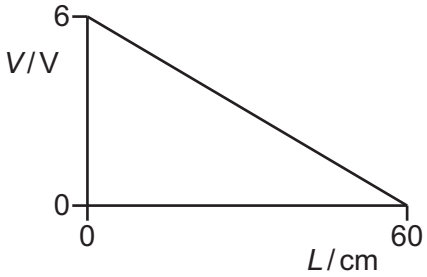
A



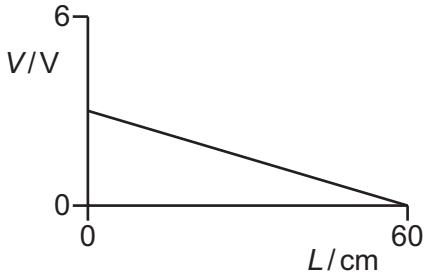
B



C



D



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39 A nucleus emits a β^- particle.

What is the change to the proton number and to the nucleon number of the nucleus?

	proton number	nucleon number
A	–1	+1
B	0	–1
C	+1	–1
D	+1	0

40 How many up quarks and how many down quarks are in a nucleus of the nuclide $^{37}_{17}Cl$?

	up quarks	down quarks
A	51	60
B	54	57
C	57	54
D	60	51

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